Review of 2010 financial security at Equity Silver Mine

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Abstract

The Equity Silver Mine operated between 1980 and 1994, producing silver, gold, and copper from three open pits and a small underground operation. Future liability is important at the site due to the environmental risk and high cost of treating acid rock drainage (ARD) produced by waste rock. As a condition of the Mines Act permit, British Columbia requires the provision of financial security. Security reviews have been held every five years since 1991. This paper outlines conclusions of the 2010 review and trends in costs over time.

1 Introduction

The Equity Silver mine, now owned by Goldcorp Canada Ltd. (Goldcorp), is located in Northwest British Columbia (BC), 35 km southeast of the town of Houston. The mine operated between 1980 and 1994, producing silver, gold and copper from three open pits and a small underground operation. Additional site components include a contiguous series of waste rock dumps, a plant site, a flooded tailings impoundment, and systems for clean water diversion and collection and treatment of contaminated drainage. Future liability (cost) is important at Equity Silver due to the environmental importance and high cost of treating acid rock drainage (ARD) produced by waste rock (Aziz and MacLeod, 2010; Price, 2007). Fish habitat with people living next to the creeks occur a short distance below the mine.

The British Columbia Mines Act requires that mines provide a financial security bond, which in the event the company defaults on its obligations would provide interest payments equal to the predicted future capital and operating costs. Review of the security should occur every 5 years and more often if there are significant site changes between 5 year reviews. Previous reviews of the Equity security were held in 1991, 1995, 2000 and 2005 (EMFSTAG, 2006). Terms of reference for the 2010 security review were as follows (Price, 2011):

- Determine requirements for environmental protection and reclamation, and estimate the resulting liabilities through the examination of data and knowledge accumulated from past performance.
- Identify areas of significant uncertainty and risks to the environment, and where necessary recommend additional monitoring or research studies.
- Recommend measures, such as conditional triggers, to minimise environmental and financial risks.
- Outline results of the above, recommend permit conditions and provide rationale and supporting information.

The security review was conducted by Goldcorp, government and a public member of the Public Advisory Committee. In the security review, site costs were divided into four categories: annual lime costs, other annual operating costs, periodic costs and economic and financial considerations. Cost projections were limited to 100 years, since the net present value (NPV) of costs beyond 100 years are negligible. The first step was to review results of monitoring and studies of the performance and costs of all site components and mitigation activities. A working document of potential failure modes, preventative measures and additional requirements (Price et al., 2006) records risks and unknowns identified during the 2005 security review.

2 Annual lime costs

Lime[1], the primary additive in the treatment plant at approximately one million C$/yr, is the largest single cost item. There is no local lime supplier and rail and truck transportation are a significant part of the cost. The delivered lime cost includes transportation, energy surcharges, and the BC carbon tax. The cost of lime has increased over time, and peaked in August 2008 due to high natural gas and fuel costs (Table 1). The security was recalculated in August 2008 because unit lime costs exceeded the 10% trigger recommended in the 2005 security review. Since August 2008, decreased energy costs and taxes have reduced the unit lime cost.

Table 1 Percent increase in unit cost per tonne of delivered lime

1995	2001	2005	Aug 2008	May 2010	Sept 2010
16%	21%	51%	88%	82%	74%

The September 2010 unit cost for delivered lime was used for the 2010 financial security review. To avoid recalculating the security in response to short-term spikes in price, the trigger for unit lime cost was reworded from previous reviews to state that the increase or decrease of more than 10% in the price must be for at least 6 months before the security shall be recalculated and adjusted using the new lime costs.

The mass of lime used each year has varied by more than 200% from 3000 and 7000 tonnes (Aziz, 2010) (Figure 1). The main variable affecting the volume of waste rock dump drainage is precipitation, especially the magnitude of the April to June spring snow melt. July to June lime use is preferred over calendar year lime use because July-June data includes snowmelt and the corresponding snowfall, enabling a comparison of annual lime use and precipitation.

Annual lime use depends on the volume and acidity of dump drainage and roughly follows a mass balance with weathering products accumulating along flow paths during years with low flow and flushing during years with high flow events (Morin and Hutt, 2010). In the last fifteen years, the site has had three major spring run-off events: 1 in 30 year in 1997, 1 in 40 year event in 2002 and 1 in 50 year in 2007. The large fluctuations in precipitation and snow melt make it difficult to identify trends in lime use (Figure 1). A useful statistic that assists in tracking lime use trends while decreasing lime use variability due to annual precipitation is the three year rolling average for lime consumption using the July to June period.

The wide range in flow potentially masks changes in the acidity of dump drainage. The critical acidity concentrations are the lowest values each year, which are concentrations during spring snowmelt, the period of maximum acidity loading. The concentration of acidity during spring run-off has increased from 4000 mg CaCO3 /L up to 8000 CaCO3 /L over the last 15 years (Aziz, 2010) (Figure 2). A statistic used to check for major changes in drainage acidity is lime use normalised for the difference between annual precipitation and 655.3 mm, the average precipitation in a previous security review.

Site changes that have affected the volume and strength of dump drainage over time were the production of more waste rock (1980 to 1994), construction of a soil cover from 1990 to 1994 and rebound of the water table when the Main Zone pit lake reached its present height in late 1999. Average lime use increased with production of more waste rock up until construction of the soil cover, then decreased until the Main Zone pit lake reached its present height in late 1999 and then subsequently increased (Aziz, 2010) (Figure 1).

1 Lime is calcium oxide (CaO). It is also referred to as quick lime and is produced by heating limestone ($CaCO_3$) above 550°C in a kiln. Lime is used to make calcium hydroxide [$Ca(OH)_2$] or hydrated lime, a cost effective neutralising agent.

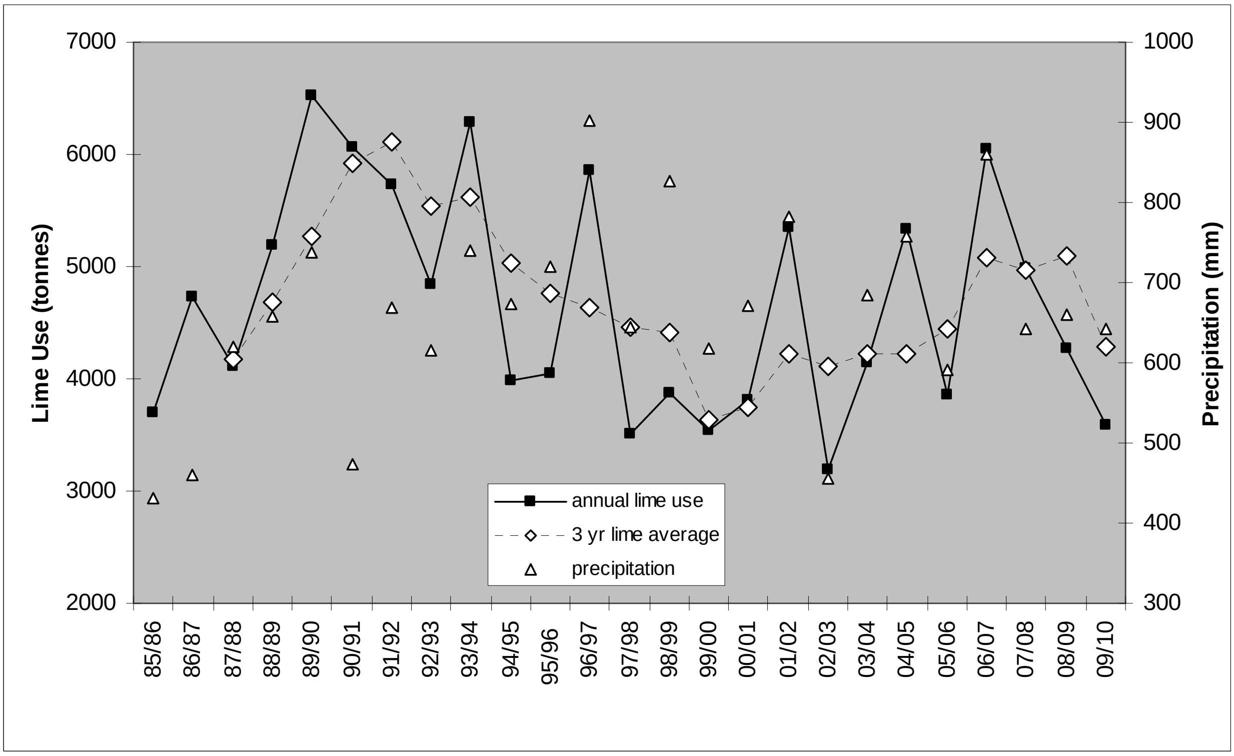

Figure 1 Precipitation and actual and 3 year rolling average July-June lime use (Aziz, 2010)

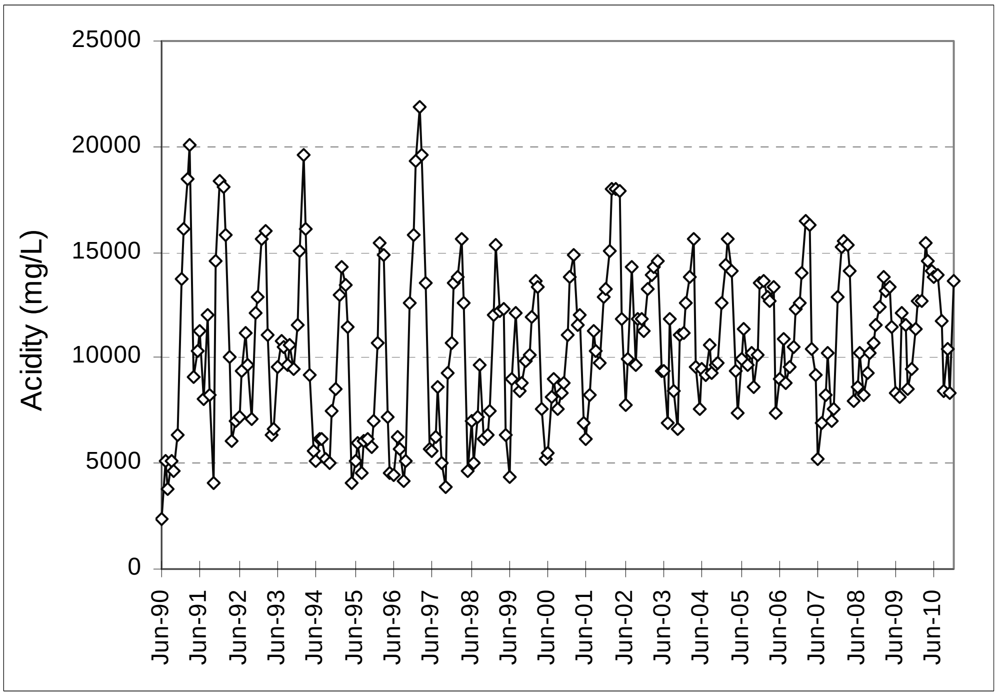

Figure 2 Acidity concentrations in combined drainage from the waste rock dumps (Aziz, 2010)

Models of future lime use and the parameters used in the current and previous security reviews are shown in Figure 3 (Aziz, 2010) and Table 2. The parameters recommended for calculation of future lime costs in 2010 were:

1. Present rate of annual lime use of 4500 t/yr
2. Present rate of annual lime continuing for 20 years
3. After 20 years, rate of annual lime use decreases 5% per year until it reaches 1125 t/yr (25% of 4500 t)
4. Lime use is 1125 t/yr for remainder of 100 year NPV period

A present base rate of annual lime consumption of 4500 t/yr was a compromise between 4400 t/yr proposed by Goldcorp, based on rounding up 4368.5 t/yr, the average lime use from 1999/2000 to 2009/2010 and 4600 t/yr proposed by the Ministry of Energy and Mines (MEM) which was based on rounding up 4547 t/yr, the average July to June lime use from 2005/2006 to 2009/2010.

There is considerable uncertainty about future lime use. A decline in lime use will eventually occur, but it is impossible to predict the timing and form of the decrease, or whether this might be preceded by an increase in lime use. The trigger to review annual lime use before the next 5 year review is if the three year July to June rolling average is 1000 t above and below 4500 t/yr. A requirement to review relevant site features before any change could occur was added to address concerns that low lime use due to low precipitation may result in high lime use in subsequent years when precipitation increases and accumulating weathering products are eventually discharged. A rolling three year average lime use was adopted so the security would only be reopened if there was a sustained change.

Since the soil cover was completed, lime use and lime use projections have steadily increased with ‘present lime use’ increasing from 3500 t/yr to 4000 t/yr to 4200 t/yr and now 4500 t/y (Table 2 and Figure 3). The period of present lime use has increased from 0 to 10 to 20 years and the subsequent rate of decline in lime use has decreased from 10 to 5%.

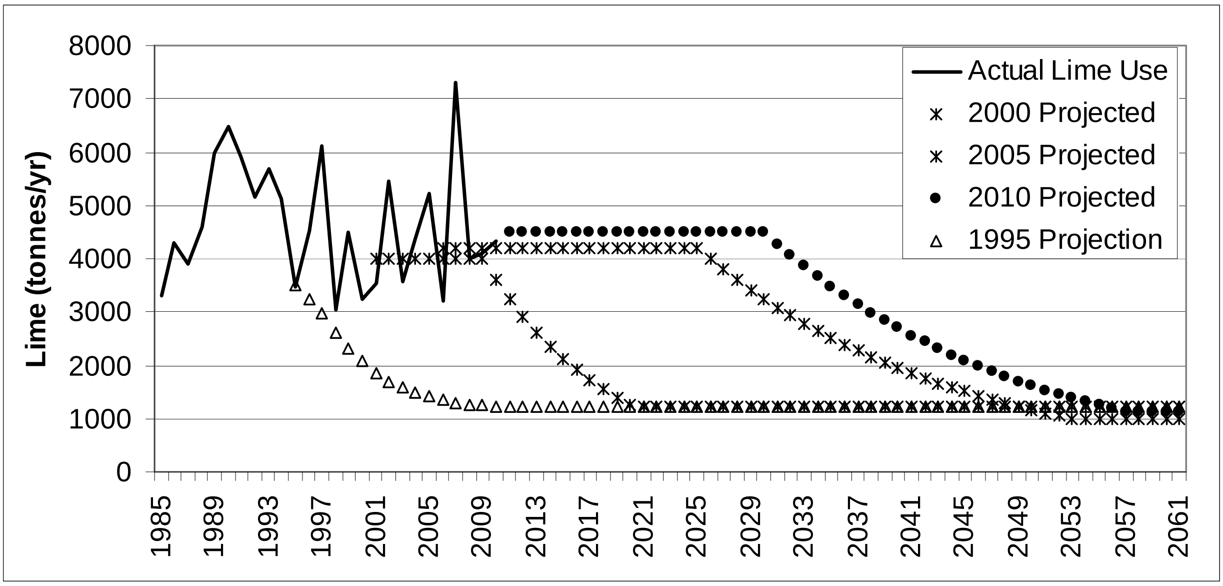

Figure 3 Actual and 1995, 2000, 2005 and 2010 projected future lime use (Aziz, 2010)

Table 2 **Rate of annual lime use in the 1995, 2000, 2005 and 2010 securities**

Year	Present Lime Use (t)	Continue Present (yrs)	Decline Rate	Post-Decline Lime Use (t)
1995	3500	0	10%	1233
2000	4000	10	10%	1233
2005	4200	20	5%	1050
2010	4500	20	5%	1125

3 Non-lime annual operating costs

Non-lime annual operating costs include salaries, services, spare parts and power for treatment, drainage diversion and collection, sludge disposal, effluent discharge, dams, roads, power lines and buildings. Tasks include operation, monitoring, maintenance, repair, supervision and reporting. The largest cost items are salaries and services (approximately 250,000 C$/yr) and power (approximately 130,000 C$/yr).

The site has 3.5 employees with the manager working half time on other projects. In 2001, the staff was reduced to 3 employees. The staff number was increased back to 3.5 after the large snowmelt in 2002. Although additional tasks have since been added, the number of personnel has remained the same due to increased automation and ease of operation of the pumping/treatment system, reduced sludge handling with the new high density sludge (HDS) plant, and decreased supervision time.

Three of the employees have between 20 and 30 years of experience. In 2010, Goldcorp requested that the security provisions for wages not penalise the company for keeping long-term employees with higher than average wages or training programs for new employees such as job shadowing. A standardised wage was used in the 2010 security with two employees at 47,000 and two at 53,000 C$/yr respectively. Total wages used in the 2010 security were 200,000 C$/yr, plus 30,000 C$/yr (15%) for benefits.

Overall non-lime annual operating costs have increased over time (Table 3). The exception is 2001, when there was a temporary reduction in staff. The non-lime annual operating cost used in the 2010 security of C$603,554 was based on costs over the last five years and the 2010 budget. Increases in non-lime costs have resulted from increased energy costs, additional toxicity tests required when the mine started to discharge drainage from the Main Zone Pit, heating the new HDS plant and added Worker Compensation Board and insurance costs. Cost items that have decreased have been sales tax and wages, with the adoption of a standardised wage.

Table 3 **Non-lime annual operating costs used in the security**

1991	1995	2001	2005	2010
C$443,000	C$520,000	C$490,000	C$595,575	C$603,554

Although government self-insures, insurance costs are included in the security based on the likelihood that if the Province managed the site it would contract out the work as it does already at the crown owned Britannia Mine. Types of insurance include automobile insurance, Commercial/Comprehensive General Liability Insurance (C$5 million), All Risks Property Insurance, Comprehensive Boiler and Machinery Insurance (C$10 million), and Worker Compensation Board Insurance. Industry costs such as permit fees and head office costs were not included in the security.

Power use is roughly 40% for the treatment plant, 50% for pumping and 10% for the office and shop. Power costs depend on unit power costs and the volume of water collected and treated. Consequently, there is considerable variation (Table 4). The trigger in the security for significant changes before the next 5 year review is a 50 % increase or decrease in the two year rolling average power costs for at least 6 months.

The security has never included a trigger for overall annual operating costs so as not to deter work by Goldcorp to reduce long-term site costs.

4 Periodic costs

Periodic costs are infrequent or one time site improvements, monitoring, maintenance or repair. The reduction in periodic costs from 1991 to 1995 resulted from the completion of reclamation activities when the mine closed, such as building removal, revegetation and the construction of sumps and the soil cover, (Table 4). The subsequent increase in periodic costs between 2000 and 2005 was the result of adding in the environmental effects monitoring (EEM) studies every 4 years and adding major infrastructure maintenance every 20 years. Details regarding the timing, frequency and costs of projected future periodic work in the 2010 security are outlined in Table 5.

Table 4 Periodic costs in the security

Year	1991	1995	2000	2005	2010
Cost (C$ million)	5.47	2.17	3.15	7.95	7.85

Cost estimates for periodic activities that have occurred previously, equipment repair, lime tailings pond and EEM studies, have been relatively accurate. Equipment repair refers to mobile heavy equipment and is planned every 5 years. Lime is periodically added to the tailings pond to maintain pH 7.5. EEM studies refers to the comprehensive environmental effects monitoring (e.g., fish, sediments, benthics, etc.) required every 4 years by the Ministry of Environment Permit. Cost estimates for the previous items are based on previous costs.

Table 5 Timing, frequency and individual and total periodic costs (Aziz 2010)

Category	Start	End	Every	Cost (C$)	# / 100 years	Total Cost (C$)
Equipment Repair	2011	2110	5 yrs	50,000	20	1,000,000
Lime Tailings Pond	2011	2110	5 yrs	15,000	20	300,000
EEM Studies	2014	2110	4 yrs	100,000	25	2,500,000
Cover and Drainage Systems	2020	2020	2020	250,000	1	250,000
Cover and Drainage Systems	2030	2110	10 yrs	100,000	9	900,000
General Site Improvements	2015	2110	10 yrs	50,000	10	500,000
Maintain Major Infrastructure	2030	2110	20 yrs	500,000	5	2,500,000
						7,950,000

Cost estimates for the periodic improvement and repair of major infrastructure are less well grounded and to date have been the cost item previous security reviews have been least successful in predicting. Improvements to collection and treatment following unplanned discharges during large snow melt events in 1997 and 2002 greatly exceeded cost projections in the 1995 and 2000 security reviews, respectively. Following the 2002 flood, there were over C$15 million in unanticipated site improvements, including:

- Dam raises and creation of an Emergency Pond capable of storing a full year of ARD.
- Construction of a HDS treatment plant.

- Purchase and installation of new pumps, pipelines and electrical equipment, and a new pump house, silo and genset.
- Improvements to pumping barge in the Main Zone Pit and the Low Density Sludge (LDS) treatment plant.

Notably, no major site improvements were required after the 2007 flood event which was comfortably handled by the improved facilities.

The last four categories in Table 5, are cost estimates for periodic improvement and repair of the soil cover and the drainage collection and treatment systems. There is a lack of previous experience regarding the durability and future maintenance and repair needs of soil covers and drainage collection and treatment systems. This results in uncertainty about future costs and when to initiate corrective work. The cost of cover maintenance over the past fifteen years have been minimal and were accounted for in normal operating costs: 1,000 C$/yr to remove woody shrubs, several 1,000s C$/yr for pre-freshet ice removal from ditches and C$80,000 once to repair ditch damage. Projected repair costs in the security for the cover and other aspects of the drainage diversion and collection system are C$250,000 in ten years time (2020) followed by C$100,000 every ten years thereafter. Less specific infrastructure cost items include small site improvements (C$50,000) every 10 years and major infrastructure (e.g., pump houses, pipelines, treatment plants etc.) repair and replacement (C$500,000) every 20 years.

5 Economic and financial considerations

Economic and financial considerations in the security review include discount rates, inflation and the financial health of the mine owner. Discount rates used to calculate the net present value have a significant effect on the size of a security. Discount rates used in the security are based on 30 year Government of Canada real return bonds (“rrb”), a market-based estimate of the risk-free, real rate of return. Real return bonds yields have been steadily declining (Table 6) and have been less than 2.0% for most of the time since 2005. The expectation is that rates will remain low until the next review in 2015. The recommendation of MEM and Goldcorp economists was that costs be discounted at:

- 1.50% from 2011 to 2015 (next review)
- 2.0% from 2016 to 2044 (when recently issued real return bonds matures)
- 3.0% from 2044 until 2110

Table 6 Discount rates used in the security

Security Review	Discount Rate Applied (%)		
	Initial	Second	Third
1995	4.25	3.5	
2000	4.0	3.5	
2005	2.0	2.5	3.0
2010	1.5	2.0	3.0

The conclusion of the economist for MEM was that the mine owner Goldcorp is a large, geographically diversified mining company, and should be able to fund operating and capital costs, and provide any additional security necessary. Economic triggers for recalculation of the security before the next five year review are if:

- Changes in discount rates based on yields for Government of Canada real return bond will result in a security reduction of at least Four Million dollars (C$4,000,000).
- Cumulative annual inflation reported by the British Columbia Consumer Price Index (BC CPI) exceeds 10%.

Table 7 Lime, annual operating, periodic and total NPV security costs

Security	NPV (C$ million)			
	Lime	Operating	Periodic	Total
1991	17.7	14.7	5.5	37.5
1995	6.7	14.2	0.7	21.6
2000	10.2	12.4	1.0	23.6
2005	21.7	21.3	2.8	45.8
2010	29.2	24.1	3.0	56.3

6 Conclusions

The NPV of the projected lime, annual operating and periodic costs is C$56 million: C$29 million for lime, C$24 million for annual operating costs and C$3 million for periodic costs (Table 7). C$4.5 of the C$10.5 million increase in NPV costs from 2005 to 2010 was due to a decrease in discount rate from 2.00% to 1.50%. C$6 million was due to increases in projected site costs. Lowering the discount rate has been responsible for approximately 50% of the increases in previous security reviews. The increase in the size of the security continued this trend since 1995 (Table 7).

Provision of the new security, security triggers, reporting lime use and other major costs, and a program to address key outstanding issues were conditions in a revised Mines Act permit. The Mines Act permit sets general objectives and program requirements, but does not prescribe the details. In this manner it allows the company a degree of flexibility with site management, and enables them to be cost effective. The security report recognised that Goldcorp has been a responsible and proactive mine owner and recommended a continuation of a proactive, transparent approach to mitigation, monitoring, maintenance and communication of the results (Price et al., 2011).

The 2011 review illustrates the uncertainty regarding future maintenance and repair of soil covers and contaminant loading from waste rock dumps. Previous underestimation of remedial costs resulted from a difficulty in measuring key properties, a lack of previous experience with many aspects of prediction and mitigation, a lack of reviewers on the part of government for certain technical disciplines and optimistic projections by technical experts. Although concerns were identified, there was insufficient evidence to support spending of large amounts of money or increasing the size of the security beyond that recommended in the review.

The major floods resulting from high snow packs (1997, 2002 and 2007) in the five years preceding each of the last three security reviews has improved understanding of the mitigation needed to handle wet years. Further long-term operating experience is needed to more accurately estimate future durability and maintenance costs. In the mean time, the mine owner, government and stakeholders will continue to rely on a combination of comprehensive monitoring, frequent preventative maintenance and repair, and conservative mitigation plans.

Acknowledgments

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